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SEPTIC TANKS FOR RURAL HOMES

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Division of Farm Engineering

INTRODUCTION

In the development of the modern farm home no problem is more vital to the health, convenience, and comfort of the family than the proper disposal of sewage and other household wastes. The almost constant call for definite information on this problem, and more especially on the principles, construction, and installation of the septic tank, shows the growing interest of the rural public in this important matter and also seems to justify the preparation and distribution by this department of a practical bulletin on the septic tank for individual rural homes.

With the advent of running water in the home, suitable provision for disposing of the used water becomes imperative; that is, a sewage disposal plant must be provided.

The writer is largely indebted to the following men and bulletins for the exact detail on many scientific points and for support of his own experience, theory, and deductions:

George F. Krogh, who made the drawings.

John T. Stewart, Minnesota Farmers' Institute Annual No. 27 (1914). (Out of print.)

F. F. Frazier, Sewage Disposal for Country Homes. Kansas Engineering Experiment Station Bulletin 5 (1916).

Robert W. Trullinger, Water Supply, Plumbing and Sewage Disposal for Country Homes. U. S. D. A. O. E. S. Bull. 57 (1914).

C. A. Ocock and W. H. Wright, Sewage Disposal for Rural Homes. Wisconsin Agr. Exp. Sta. Circular 34 (1912).

Oscar Erf, Disposal of Dairy and Farm Sewage and Water Supply. Kansas Agr. Exp. Sta. Bull. 143 (1907).

METHODS OF SEWAGE DISPOSAL

There are three principal methods of sewage disposal:

1. The Dilution process—by discharge into a running stream where it is purified by the natural processes resulting from exposure to light and air and running water.

2. The Reduction process—reducing the amount of suspended matter either by some form of precipitation or by changing to liquid and final oxidation, that is, breaking up by contact with fresh air. The method of precipitation still leaves the problem of disposition of considerable quantities of solid matter, or sludge.

3. The Percolation and Absorption process—by discharge onto fields in broad surface irrigation or into the common cesspool, disintegration taking place with greater or less rapidity according to the degree of exposure to light, air, and soil bacterial action.

It is therefore quite evident that, for various reasons, none of the other processes above described is so well suited to general rural conditions as the second type of reduction, that of liquefaction. This, in fact, is the type most commonly recommended and employed for farm homes.

PRINCIPLES OF SEWAGE DISPOSAL

Sewage disposal means primarily the carrying away and discharge of sewage, but it has also come to mean by implication the purification or breaking up of the sewage and so rendering it harmless. Sewage changes its character quite rapidly with age and the local conditions affecting the action of bacteria present in it. In scientific consideration of its disposal, the following general facts must be taken account of:

1. Fresh sewage contains considerable free atmospheric oxygen from the water supply and this oxygen under the influence of the bacteria also present rapidly oxidizes much of the organic matter. This process is inoffensive and results in what is commonly known as stale sewage.

2. Sewage begins to decay in from one to two and a half days after its discharge into a sewer or septic tank.

3. It is decomposed by oxidation and reduction.

4. The only true purification is by oxidation, which does not destroy the matter but simply transforms it into harmless compounds.

Ordinarily sewage from farm homes contains almost anything to be found in waste product from human excreta to dairy wastes and soapy water. The bacteria therefore are varied in character, some beneficial, some harmful. The resulting waste contains much solid matter in suspension as well as that which is in complete solution. It is the suspended matter that causes the most difficulty, as the matter in solution is much more readily oxidized.

The primary object, therefore, in a system for final sewage disposal is the removal of as much of the suspended matter as practicable, either by precipitation or by chemical liquefaction and oxidation.

THE SEPTIC TANK PROCESS

The septic tank process is essentially one of liquefaction. It is composed mainly of two stages determined by the differing character of the bacteria instrumental in the action. One class of these bacteria (the anaerobic) will not thrive in the presence of light or of free oxygen in any great quantity, or in physical disturbance of their habitat. This class, therefore, is the first to perform its function in breaking up the greater portion of the organic solids into various gases and liquids, leaving also a certain residue of finely divided suspended matter. The septic tank must therefore be so constructed as, first of all, to provide the proper environment for the anaerobic bacteria. Bacteria of the other class (called aerobic) require the presence of light and the free oxygen of the air to promote their growth and activity. Aerobic bacteria take up the work where the anaerobic bacteria leave off and complete the process of decomposition into simple gases and pure water. The second feature therefore in the proper design and construction of the septic tank system is to provide the proper environment for the aerobic bacteria.

Sewage from the farm home will contain in addition to paper a considerable amount of more or less finely divided inorganic matter not affected by the bacterial action. These will unavoidably cause some precipitation as sludge. The successful operation of a septic tank, therefore, depends on the completeness of the bacterial action in reducing the quantity of suspended matter to a minimum and on final disposition of the sludge. This reduction will amount to from 30 to 70 per cent of the entire suspended matter. The nature and peculiar sensitiveness of the anaerobic bacteria make imperative the proper design of the septic tank as to size, shape, and precautions for protection of the bacterial habitat.

DESIGN OF SEPTIC TANK

While one-chamber tanks under exactly proper conditions have been used with success, the best results in individual homes are usually obtained with two-chamber tanks. It is the intention therefore to confine this discussion to tanks of two or more chambers.

The first chamber, which receives the raw sewage from the house drain, is called the sludge chamber or septic chamber. The second, from which the final discharge from the tank takes place, is called the dosing chamber.

Experience has shown that sewage should remain in the tank from 10 to 36 hours and for ordinary house sewage 24 hours has been found to be about right. Hence the sludge chamber should be of sufficient capacity below the scum line to hold all the sewage that will be deposited in it during a 24-hour day. In homes situated in the country or in small towns, it has been shown that the quantity of water used for all purposes amounts to a maximum of about 30 gallons, or 4 cubic feet, per person per day. From these figures the required capacity of the sludge chamber for a given household is quickly determined in cubic feet by multiplying the number of persons in the family by 4.

The anaerobic bacteria working in the sludge chamber have their active habitat in the thick scum that forms on the surface of the liquid in this chamber and provision must be made that this scum is not disturbed by discharges from the house entering the tank, by discharge from the sludge chamber into the dosing chamber, or by any other agency. Disturbance from the house discharge into the tank may be prevented either by running the intake pipe below the fluid surface in the sludge chamber as shown in Figure 1b, or by the construction of a baffle wall in front of the intake as shown in Figure 1. The latter seems preferable as giving no chance for clogging of the intake pipe.

Disturbance from discharge into the dosing chamber is prevented either by the use of discharge risers with the opening at the bottom on the sludge-chamber side and at the top and just even with the liquid surface in the sludge chamber on the dosing-chamber side as shown in figures 1 and 1a, or by means of baffles extending well below the liquid surface as shown in figures 4 and 5. The capacity of the dosing chamber must be governed largely by the method of final disposal to be used, and it need not always be as great as that of the sludge chamber.

For the first two methods discussed of final discharge from the tank, the dosing chamber will ordinarily need to be practically the same size as the sludge chamber and the discharge should be through risers similar to those between the two chambers so that a small discharge is almost constant, occurring at every discharge from the house system into the tank and in equal amount. For the type where an absorption bed is used, the capacity of the dosing chamber, especially its depth, need not be as great as that of the sludge chamber. In fact a less depth is often of advantage in enabling one to plan the discharge sufficiently near the surface to make a proper disposal bed possible.

Where the absorption system is used, the discharge should be intermittent, occurring not more than once or twice every 24 hours. This can be effected either by means of a plug valve to be pulled by hand once in about

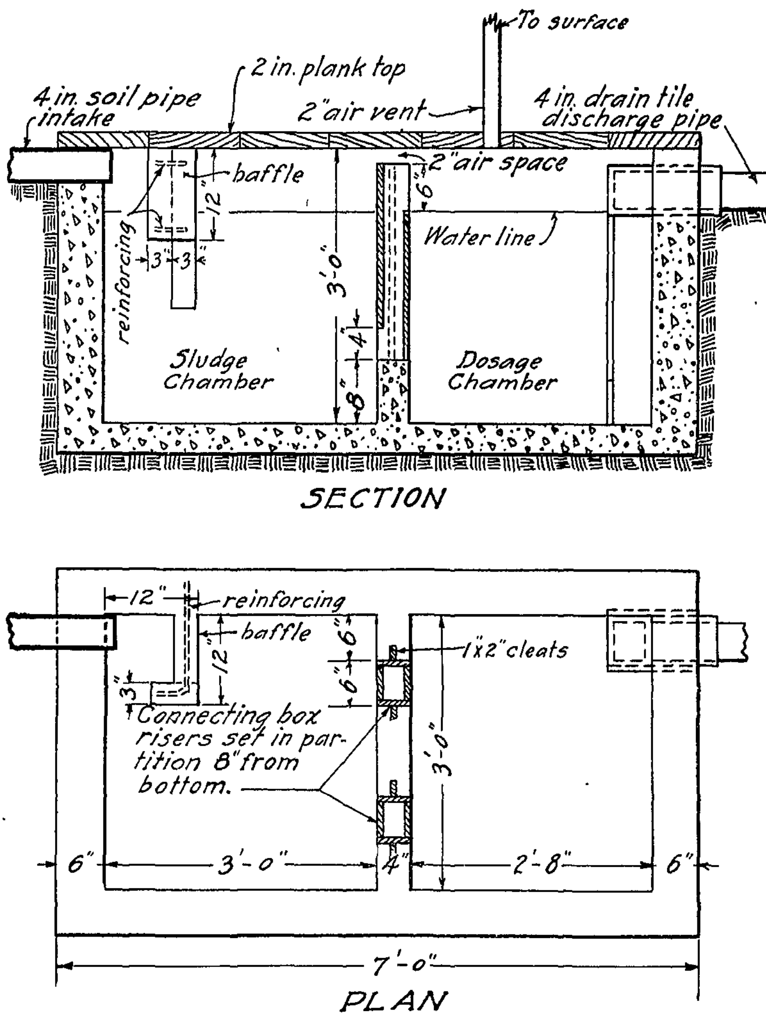


Fig. 1 Two-Chamber Septic Tank for Five or Six Persons (Steady Discharge)

every 24 hours and replaced as soon as the dosing chamber is empty, or by means of an automatic siphon, the discharge in either case taking place through the bottom of the dosing chamber. The hand-operated plug may be of wood with a long handle to the top of the tank or ground surface or it may be made of iron pipe as shown in Figure 7A. Figure 5A, after Kansas Engineering Experiment Station Bulletin No. 5, shows a section of the automatic siphon and its condition after discharge. The U-trap is filled

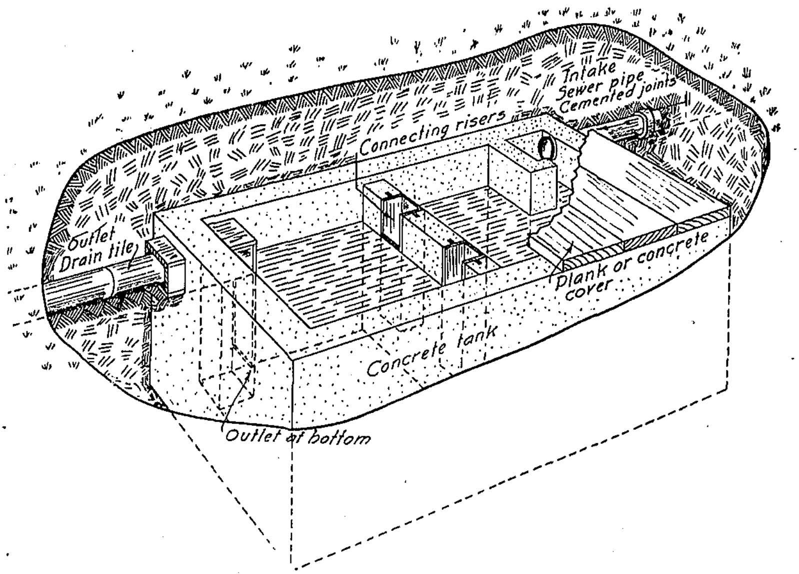


Fig. 1a Perspective View of Tank Like Figure 1

with water, and air is entrapped in the higher leg by means of a bell over the top as the sewage is discharged into the dosing chamber and its surface rises above the edge of the bell. The sewage is prevented from discharging by the weight of the sewage in the lower right-hand leg of the siphon. When the surface in the chamber has risen high enough that the resulting head on the bell end of the siphon overbalances the pressure of the column in the other leg, part of the sewage in that leg will be forced out and this starts full flow through the trap, which continues until the chamber is emptied. When the level in the dosing chamber falls below the rim of the bell, air is again admitted under it, the pressures are again equalized, and the flow ceases. As the level of the liquid in the dosing chamber again rises above the bell, the siphon is closed and ready for a repetition of the action at the proper time.

There should be an air vent into the space above the sewage in the dosing chamber, and an overflow into the discharge below the siphon should be provided to carry off the sewage should the siphon for any cause refuse to work; but any such failure of the siphon should be investigated and remedied as soon as possible.

METHODS OF FINAL DISPOSAL

There are in general three methods of final disposal growing out of experience in practice.

1. **Into farm drain tile.**—The first and simplest method is the direct discharge of the liquid from the tank into an ordinary farm tile drain. Not less than a 4-inch tile should be used and the fall should be about 1½ inches in 100 feet. If a 5-inch tile is used, it is also possible to use a flatter grade, if need be, with good results. Tile drains have been used as septic tank outlets for ten years or longer and on comparatively flat grades without showing a tendency to fill up or clog. Such a drain carries the discharge eventually into an open stream or ditch where storm waters from heavy rains completely remove it.

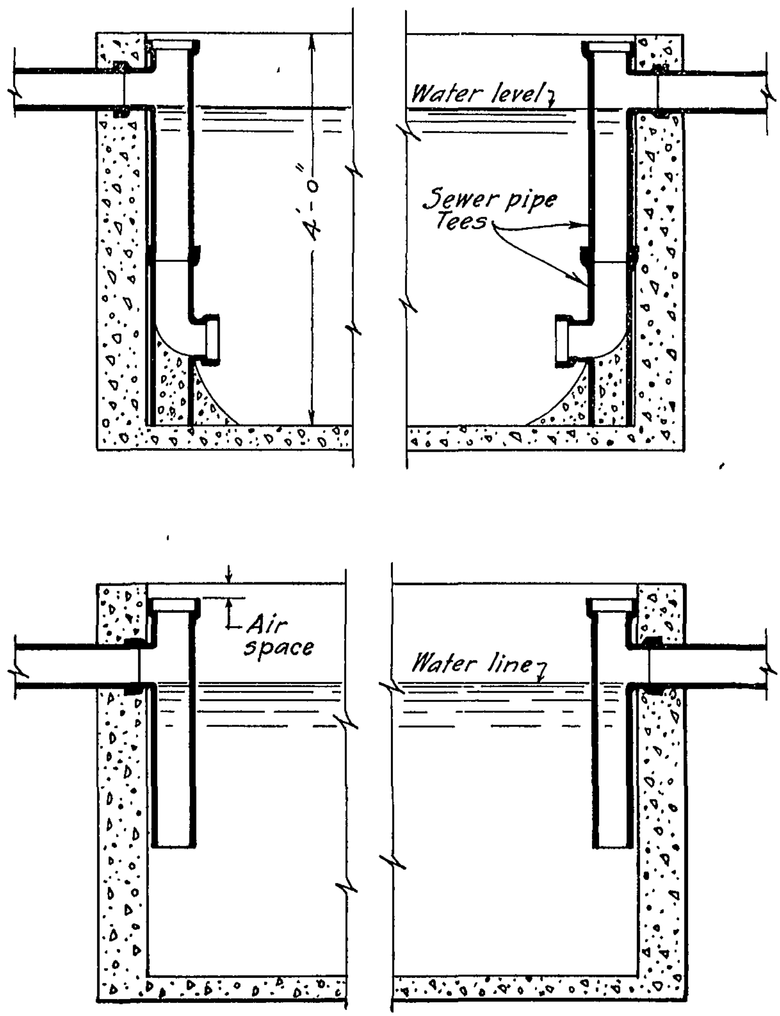


Fig. 1b Types of Discharge Below Scum

Into open ditch.—Frequently the final discharge from a septic tank is into an open ditch or ravine or out on the ground surface on a slope toward some natural water course. This type of outlet may give trouble from freezing in the winter time, thus closing it up. Therefore it is wise to get an outlet in a location as much protected as possible. It is even desirable where there is not plenty of fall away from the mouth of the outlet and where consequently there is danger of the liquid backing up into the tile and freezing, to cover the outlet in the fall with a small quantity of brush covered with a thick blanket of straw or coarse manure. If the outlet is into an open ditch that drifts full of snow that will be protection enough, as the discharge will run off under the snow and no choking will occur until the ditch itself freezes and raises the ice so high that it clogs the tile.

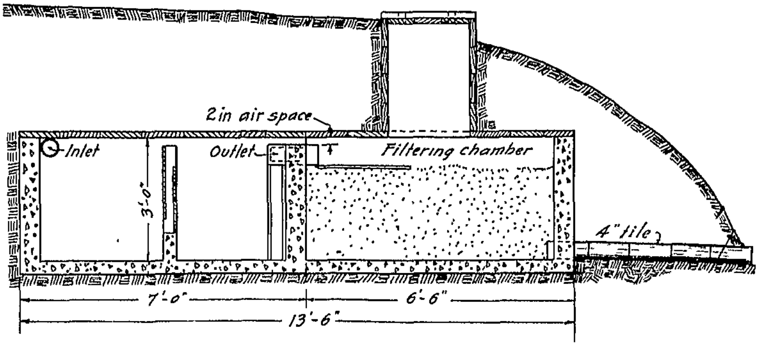


Fig. 2 Septic Tank Like Figure 1 with Filter Added

While the effluent thus discharged is not fully clarified and purified, it will not ordinarily become a nuisance unless the tank is worked beyond its capacity or other tanks discharge at the same point. At the Crookston substation a small tank discharged through such an outlet into a public road ditch for six years without offensive results, and no complaint was made until tanks from larger buildings were discharged into the same tile.

2. **The filtration method.**—The essentials of this system are shown in Figure 2, which is similar to the plan shown in Figure 1 except that a long sand and gravel filter chamber is added to the tank proper, and final discharge from this chamber must be made either as in the discharge into a ditch, or out on the ground, or into a specially prepared storage chamber or cistern, such as is shown in Figure 3. This latter plan (Figure 3) is designed for use where the surface is so flat that no natural drainage exists and where no sewer system or other under-drainage is available. If the deeper subsoil is too impervious to prevent gradual seepage into it from the loosely curbed cistern, the contents of the cistern may be pumped out on the surface every ten days or two weeks without offense. The purpose of the filter is merely to complete the purification of the liquid effluent.

There must be plenty of air present in the filter if the filtration method of purification is to be successful, and it is better to have the liquid discharge over the filter in a thin sheet or spray as this will more thoroly mix it with air. For the same reason intermittent discharge into the filter similar to that described in the absorption method will give better results. In time, too, any filter will clog and prevent the liquid from percolating through it.

When this happens the materials in the filter must be stirred up thoroly and may even have to be renewed from time to time. Sometimes offensive odors are given off from a filter receiving the effluent from septic tanks. Where this occurs the Wisconsin Experiment Station recommends the following treatment:

"Mix 1 pound of bleaching powder with 100 pounds of water and allow to settle. The clear liquid is then drawn off and sprinkled over the filter bed in about the proportion of 1 gallon of solution to 1,100 gallons of sewage. This solution does not interfere with the working of the filter but destroys the offensive odors."

Under ordinary conditions, with the top of the filter at or near the ground surface, the filter is likely to freeze in cold weather. Owing to this and the

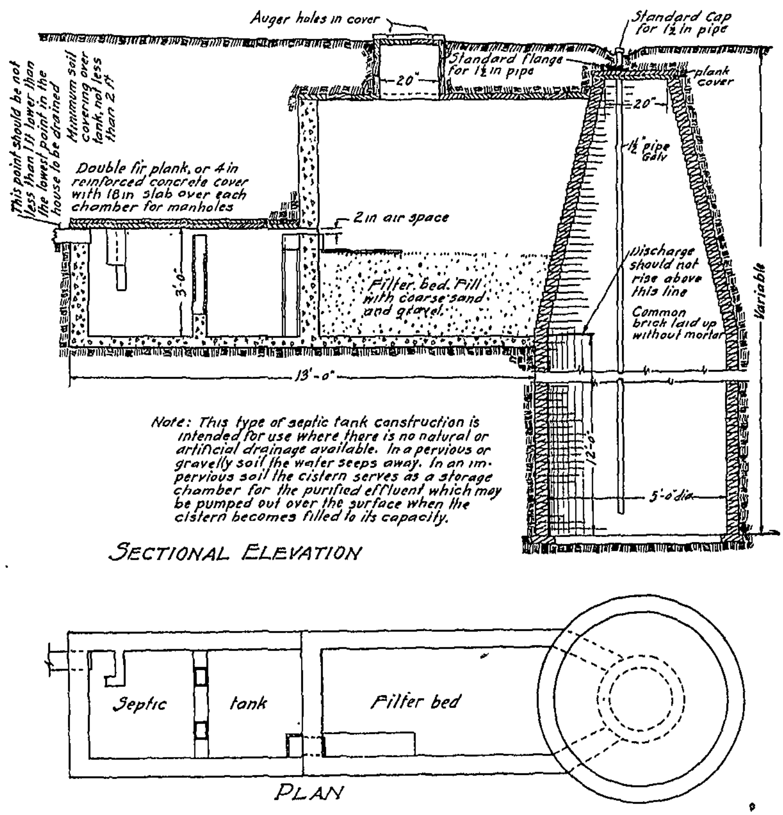


Fig. 3 Two-Chamber Septic Tank with Filter and Storage Cistern

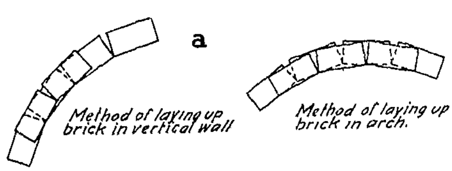


Fig. 3a Detail of Brick-Laying for Storage Cistern

general call for more care, the filtration method is not recommended for the individual house plant. But it is essential for the type of local condition above mentioned where there is neither natural nor artificial outlet, and is illustrated by Figure 3.

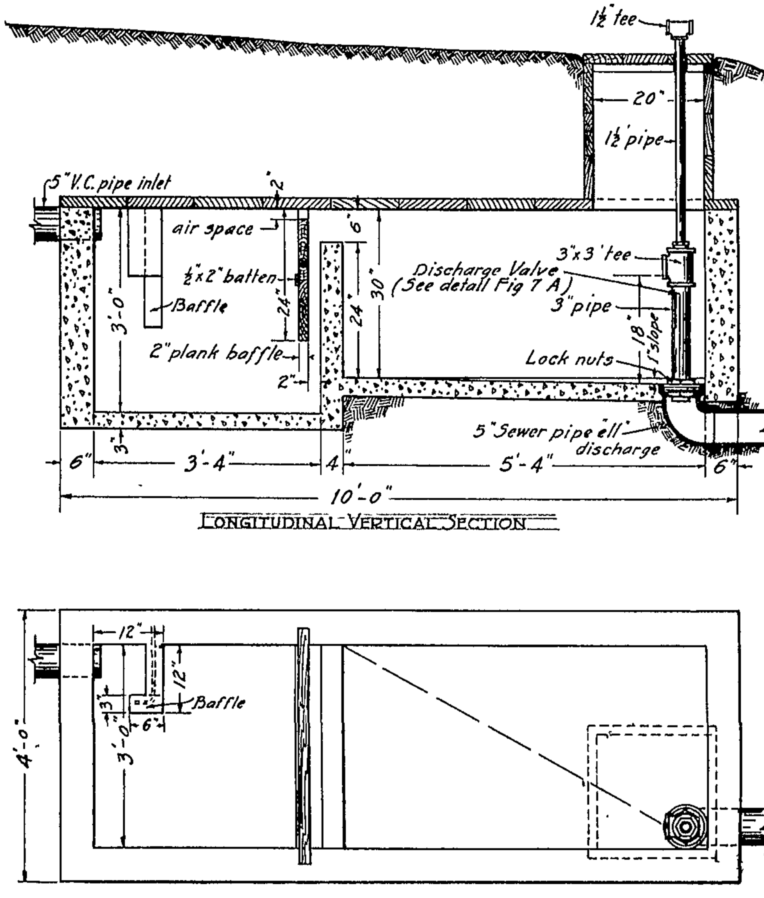
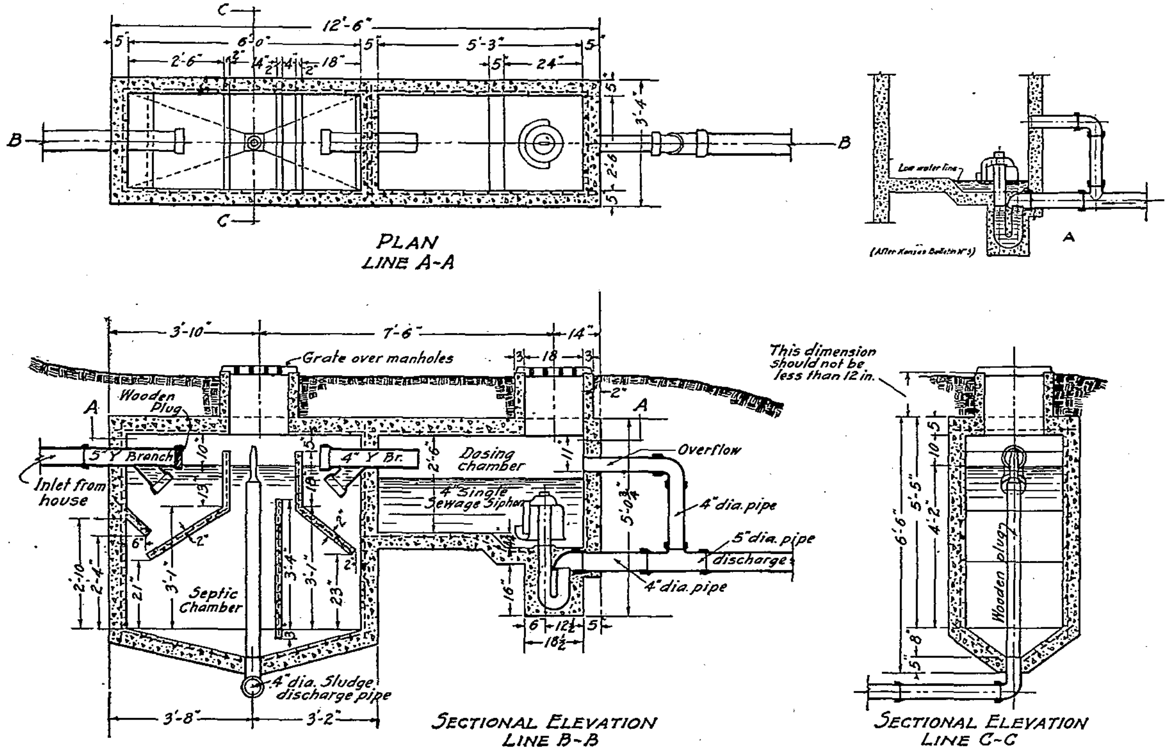


Fig. 4 Two-Chamber Tank for Five or Six Persons (Intermittent Discharge)

3. **The absorption method.**—(See Figures 6, 6a, and 6b.) This method is the most desirable where there is no running stream with sufficient flow at all times to prevent the creation of a nuisance; but for the installation of such a system there must be sufficient fall away from the house that at the final discharge into the absorption bed the outlet tile shall not need to be more than 20 inches below the natural ground surface. In this method the liquid is carried from the tank through a sewer tile drain laid with water-tight joints to a distribution chamber (Figure 6a) from which radiate lines of ordinary 4-inch drain tile laid with about ¼-inch open joints so that the liquid can readily pass into and be absorbed by the surrounding soil (Figure 6). The more open and porous the soil the better. If the natural soil is not open and



After Kansas State Eng. Expt. Sta. Bulletin No 5

Fig 5

Fig. 5a Detail of Automatic Siphon Discharge

Fig. 5 Another Type of Two-Chamber Tank (Intermittent Discharge) porous, the bed must be excavated to a depth of from 2 to 2½ feet and this excavation refilled with loose, porous soil. It is quite an advantage to surround the disposal tile with coarse cinders or cinders and gravel mixed, but the open joints must be protected with tar paper, tile bats, or other material that will prevent the soil from silting through into the tile. The tile lines should be laid very carefully to line and to a grade of about 2 inches to the 100 feet, so that the effluent will reach all parts of the disposal bed in a short time and permit as even distribution as possible throughout the soil of the bed. As the chief purpose of the absorption system is to combine the purifying influence of air and sunlight with the bacterial action in the surface soil, the top of the disposal tile should be not more than from 14 to 20 inches below the ground surface (Figure 6b), and the tile lines should be not closer together than 6 feet or farther apart than from 10 to 12 feet, according to the character of the soil and the room available. There should be from 35 to 60 feet of disposal tile for each person provided for in the tank, according to the character of the soil in the disposal bed.

If the subsoil is not porous enough to absorb rapidly all the water from the disposal bed, a secondary system of drains should be laid beneath the absorption system about two feet deeper than and alternating with the absorption tile and leading to a regular tile-drainage outlet.

The absorption system may well be placed under a permanent sod in a field or pasture lot, as the growing grass can do no harm to the tile lines and the grass roots will help to keep the soil open and loose.

Figure 6, after Kansas Engineering Experiment Station Bulletin No. 5, shows several types of arrangement of the absorption tile according to local topography and need for a secondary drainage system. The ventilators shown at the ends of the absorption lines are necessary in close, compact, top soils.

DRAIN FROM HOUSE TO TANK

The drain from the house to the tank should be of vitrified sewer pipe with cemented joints and of a diameter not less than that of the house soil pipe. It should be carefully laid with a uniform grade of 1 per cent minimum and 2 per cent maximum.

SHAPE OF TANK

There is some difference of opinion regarding the shape of the tank, but it is pretty generally conceded that the most effective shape is in general rectangular, and the larger the tank the greater should be its length in proportion to the width and depth. A fluid depth in the sludge chamber of the individual house tank of from 30 inches to 4 feet, according to capacity required, has been found to give good results. Many authorities advocate a funnel-shaped depression in the floor of the sludge chamber as a ready means of concentrating the sludge, which may be cleaned out either through a clean-out pipe furnished for the purpose, as shown in Figure 5, or pumped out by means of a sludge pump let in through the top, either permanent or made removable.

The general type shown in Figure 1 or Figure 1a, which is the same tank shown in perspective, for a family of five or six persons has been found very satisfactory by the Minnesota Experiment Station. The type of Figure 4 is also recommended. The type shown in Figure 5 is recommended by the Kansas Experiment Station as being in their experience thoroly successful.

This type is more elaborate and considerably more expensive of installation than the type shown in either Figure 1 or Figure 2. Figures 8 and 8a show larger tanks of the general type of Figure 1 designed for special cases, and in such cases, as will be seen from the plan in Figure 8, it may be considered wise to make more than two chambers. However, in Minnesota the State Board of Health discountenances the installation of this type of tank, for use at schools and other large institutions, for which they recommend the Imhoff tank, a large tank of the deep sludge chamber type not often adaptable to the individual farm home. Plans and general directions regarding the

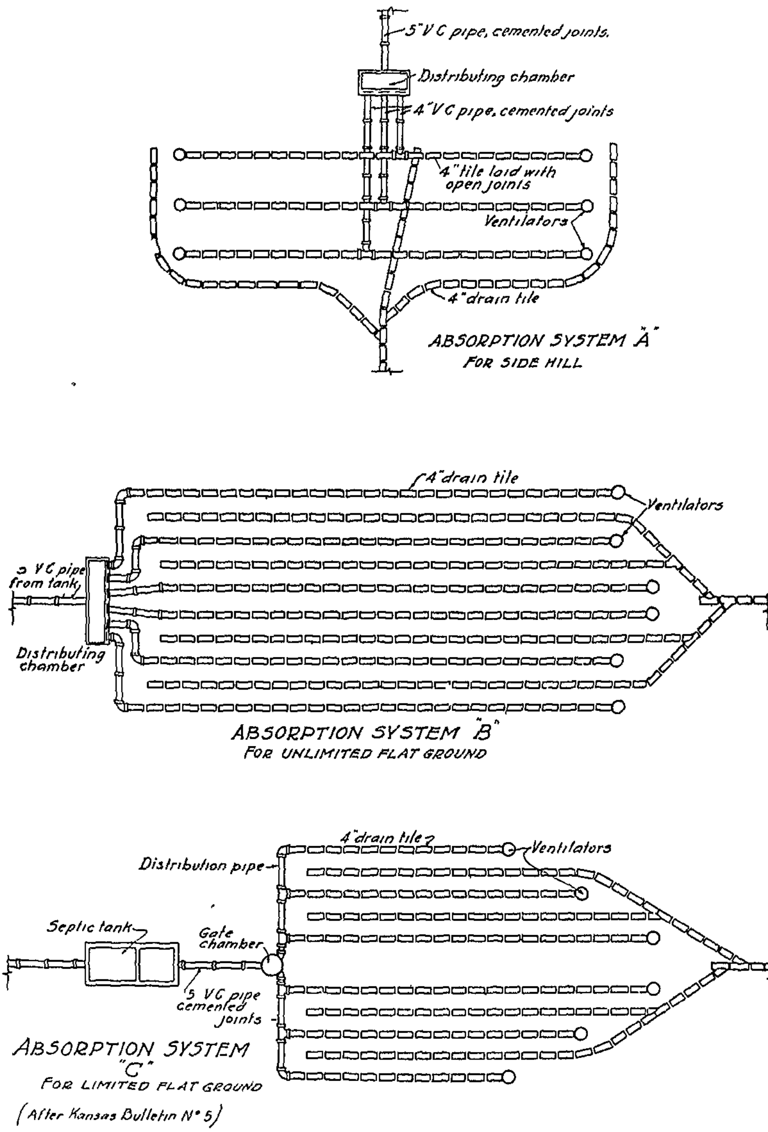


Fig. 6 Types of Absorption Systems

Imhoff tank may be obtained from the State Board of Health at St. Paul, Minnesota. It seems only fair to say, however, that the tank shown in Figure 8, designed for the public school at Heron Lake, Minnesota, is still giving excellent satisfaction and has done so throughout the ten years since its installation. The tank shown in Figure 8a is a general type designed for use by coöperative creameries in small towns and these also seem to have given excellent satisfaction during the last ten years or longer.

LOCATION OF TANK

There is also much difference of opinion as to the location of the tank. Some authorities recommend that it be placed within 4 or 5 feet of the foundation wall of the house while others say it should be placed at least 100 feet from the house if possible. The argument for the near location is that the raw flow from the house has not time to become chilled or frozen before

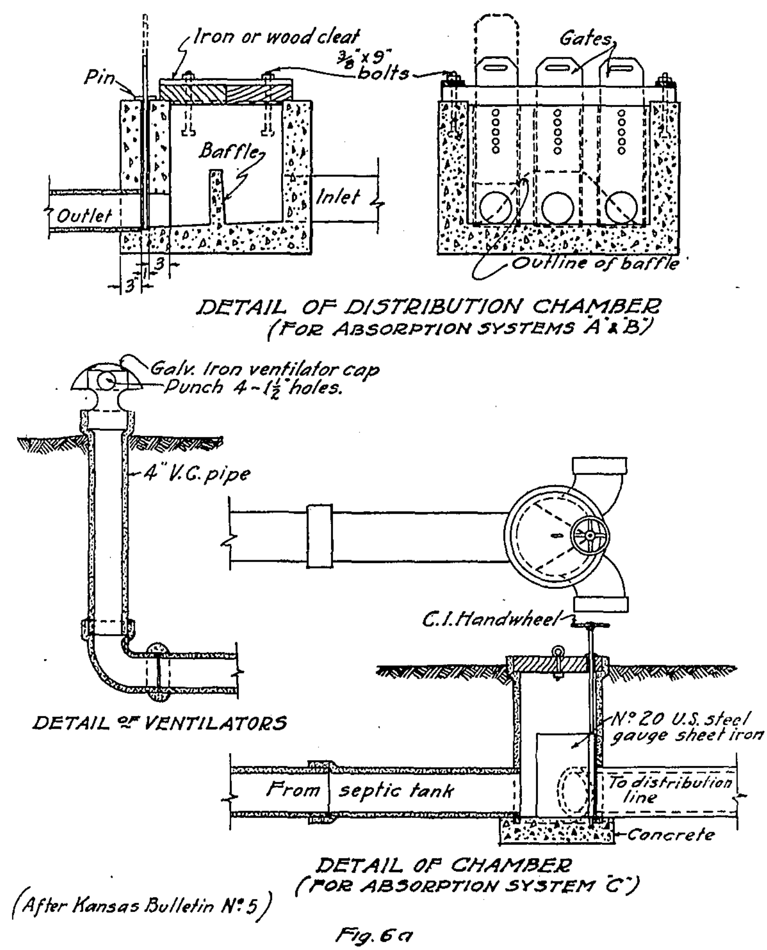
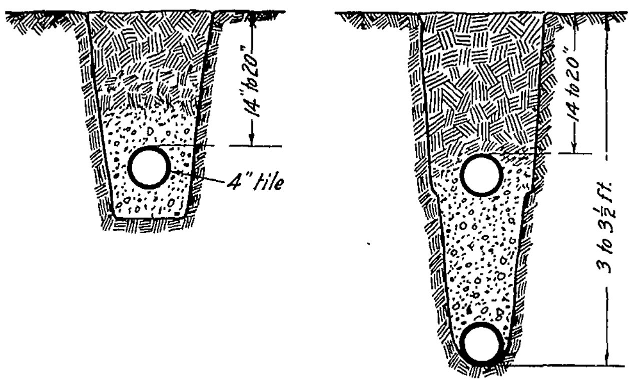


Fig 6a Details of Distribution in Absorption System

it is discharged into the tank. This is a good argument in the cold climate of Minnesota under local conditions where the lowest point in the house to be drained into the tank is above the ordinary deep frost line in the soil and thus, too, the minimum of extra depth is called for by the short drop of the discharge pipe between the house and the tank. On the other hand, however, the location near the house is likely to necessitate a long discharge pipe



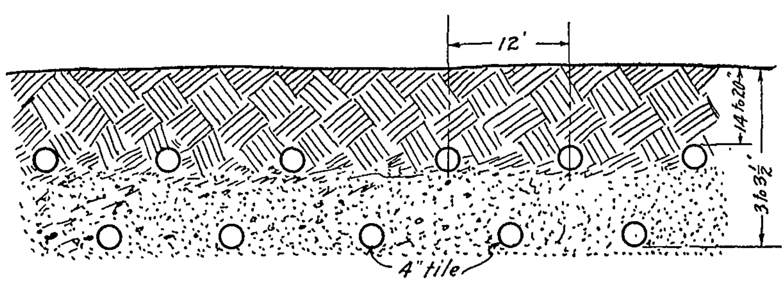


Fig. 6b Section of Absorption Bed

between the tank and the absorption bed or outlet and in this pipe the discharge is subject, it would seem, to still more danger from freezing because the final effluent from the tank is ordinarily much cooler than the raw discharge from the house. If a tank with a filter is used, and the filter develops unpleasant odors, location near the house may prove a serious nuisance.

The arguments for a location farther from the house may be inferred from the foregoing, namely, that such location reduces to a minimum the nuisance that may arise in the form of unpleasant odors near the house. If the basement is to be drained through the tank the danger from frost is slight, as the house discharge will usually be 5 feet or more below the natural surface and frost rarely reaches that depth even in Minnesota. Figure 7 shows in section the location of the tank with reference to the house and the absorption system.

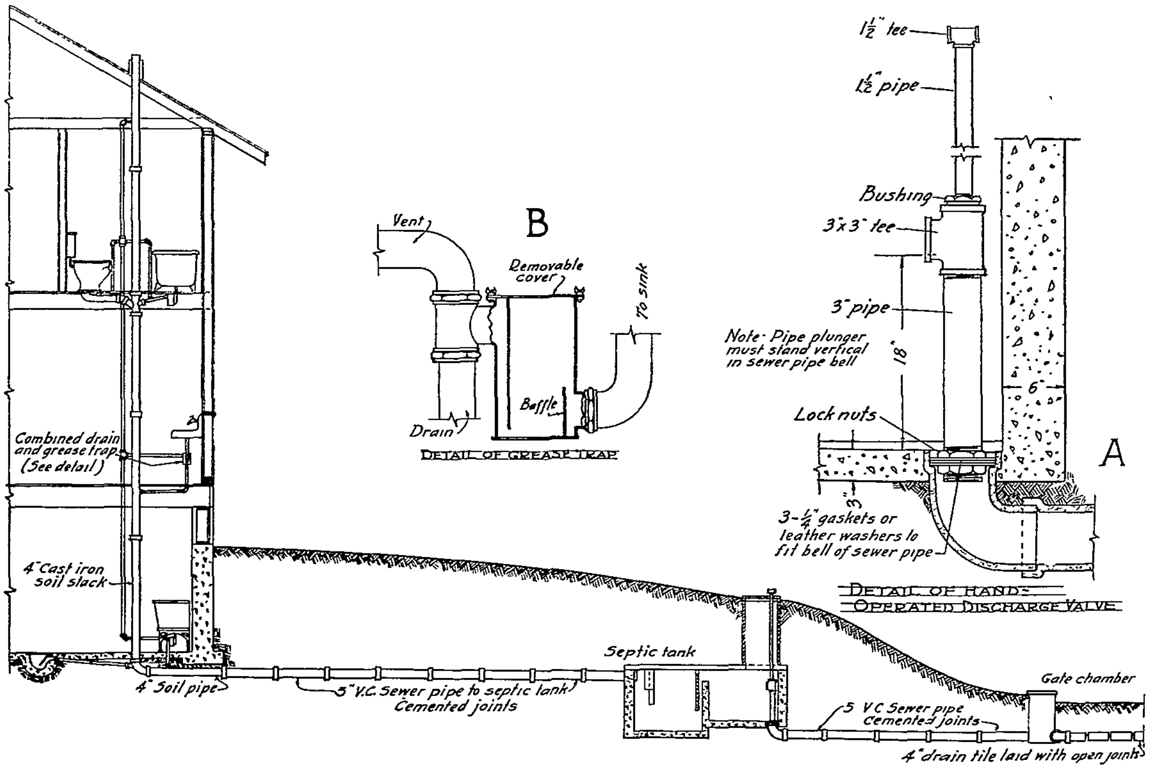


Fig. 7 Section Showing Relation of Tank to House Plumbing and Absorption Bed

Location With Reference to Wells or Other Known Water Supply

There can be no definite knowledge as to how far impurities will carry through the soil and so pollute water supplies, hence no definite rule can be laid down for different soils as to how far from wells or springs the septic tank or absorption bed should be located. It may be said most emphatically, however, that this distance should be as great as is at all possible, never nearer than 50 feet; that the septic tank and more particularly the absorption bed should be on the down-hill side of both the surface and under drainage from any such water supply; and that all conductors from house to tank and from tank to absorption bed should be of vitrified sewer pipe with thoroly cemented joints.

SPECIAL PRECAUTIONS

Neither acids nor excess of grease should be allowed to enter the septic tank, as both destroy the bacteria and the grease tends to clog the entire system.

The grease trap.—Excess grease likely to come from the kitchen sink should be caught in a grease trap, which may be obtained from any plumbing supply house. Figure 7B shows a simple grease trap in section.

CONSTRUCTION OF TANK

General considerations.—Ordinarily the body of the tank may be constructed of any class of materials from which an impervious wall can be made, but concrete will undoubtedly be found the cheapest and most convenient in most locations. The methods of mixing and handling concrete, building forms, and other allied work are so generally known that it is not considered necessary to discuss them here, as any good concrete man can build the forms and construct the tank. If the subsoil is sufficiently firm to stand by itself, the excavation can be dug true enough to serve for the outside forms, thus saving time, materials, and labor. It is advisable that the floor of the tank be put in first to serve as a foundation for the forms and any special supports that may be needed. This floor should be not less than 4 inches thick and the outside walls should be 6 inches if made without reinforcement. If made thinner, reinforcement should be used.

The cover.—This may ordinarily be made either of plank or of reinforced concrete slabs with round iron handles cast into the slabs to lift them by. As the tank will probably need cleaning out every five to seven years, it would seem that a double plank cover would be as economical and generally satisfactory as any and it could readily be renewed whenever the tank is uncovered for cleaning out. If it is desired to use concrete slabs, they should be 4 inches thick and reinforced. The width of these slabs can be made to suit, but 18 inches will be found convenient and as heavy as can be handled readily. As these should be removable, they are set loose on the tank and can therefore be cast in simple box forms at any convenient time or place and allowed to cure thoroly before they are needed. They are then easily set in place when desired.

The mixture.—The concrete should be of clean first-class materials and the mixture should be one that is practically impervious. A 1-2-4 mixture is good, altho when it is desired to use bank run gravel of good quality it may be made 1 to 4. The concrete should be a wet mixture and if necessary tamped to make it as compact as possible.

Reinforcing.—Almost any old iron that has the proper shape and sufficient strength can be used, as heavy fence wire, small gas pipe, hayrake teeth, or heavy strap iron.

Automatic siphons.—These can be obtained at a cost of from $17 to $50 according to size and type, from some of the plumbing supply and hardware companies.

BILLS OF MATERIAL AND LABOR FOR STANDARD TYPES SHOWN IN THIS BULLETIN

Under present fluctuating conditions, it is impossible to give prices of value for any length of time, but the following bills of material are exact for normal conditions where no unusual emergencies have to be met and plank covers are used for the tanks. The labor items for setting forms, concreting, and brick laying are estimates only for average conditions and may vary greatly according to local conditions.

1. **Type of Figure 1**

   Excavation of pit, figuring on cover of 2 feet of earth over tank, 6 cubic yards

   1-6/10 cubic yards of concrete requiring
   - 10 sacks cement
   - 7/10 cubic yards sand
   - 1-4/10 cubic yards gravel

   Lumber for forms, risers, and covers
   - 80 feet B.M. 1-inch rough pine or fir
   - 24 linear feet 2x4 rough pine or fir
   - 24 linear feet 1x4 S-4-S pine or fir
   - 6 linear feet 1x6 S-4-S pine or fir
   - 9 linear feet 1x2 S-4-S pine or fir
   - 28 linear feet 2x12 plank to cut to 4 ft. lengths

     Total, 166 feet, B.M.

   Iron
   - 2 pounds 10d wire nails
   - 3½ pounds ⅝-inch reinforcing iron (2 pieces 4 ft. long)
   - 2½ feet 2-inch gas pipe
   - 1 nipple for 2-inch gas pipe, 3 inches long
   - 2 2-inch elbows
   - 4- or 5-inch vitrified sewer tile according to distance from house to tank and tank to outlet

   Labor, placing forms and concreting—30 hours.

2. **Type of Figure 2**

   Excavation, figuring on cover of 2 feet of earth over tank and filter, 11 cubic yards.

   Concrete—2-7/10 cubic yards, requiring
   - 16 sacks cement
   - 1-2/10 cubic yards sand
   - 2-4/10 cubic yards gravel

   Lumber for forms, risers, and covers
   - 130 feet B.M. 1-inch rough pine or fir
   - 42 linear feet 2x4 rough pine or fir
   - 24 linear feet 1x4 S-4-S pine or fir
   - 8 linear feet 1x6 S-4-S pine or fir
   - 9 linear feet 1x2 S-4-S pine or fir
   - 76 linear feet 2x12 plank to cut in 4 ft. lengths

     Total, 324 feet B.M.

Iron
- 2 pounds 10d wire nails
- 3½ pounds ⅝-inch reinforcing iron (2 pieces 4 feet long)
- 4- or 5-inch vitrified sewer tile according to distance of tank from house

Labor—placing forms and concreting—40 hours.

3. **Type of Figure 3**

Excavation of pit and cistern, figuring on 5 feet of earth over cover—32 cubic yards

Concrete 3-8/10 cubic yards requiring
- 23 sacks cement
- 1-2/3 cubic yards sand
- 3-4/10 cubic yards gravel

Common brick—1,513

Lumber for forms, risers, and covers
- 214 feet B.M. 1-inch rough pine or fir
- 90 linear feet 2x4 rough pine or fir
- 24 linear feet 1x4 S-4-S pine or fir
- 8 linear feet 1x6 S-4-S pine or fir
- 9 linear feet 1x2 S-4-S pine or fir
- 96 linear feet 2x12 plank to cut 4 ft. lengths

Total, 480 feet B.M.

Iron
- 2 pounds 10d wire nails
- 3½ pounds ⅝-inch reinforcing iron (2 pieces 4 ft. long)
- 19 ft. standard 1½-inch galvanized gas pipe
- 1 standard cap for 1½-inch galvanized gas pipe
- 1 standard flange for 1½-inch galvanized gas pipe
- 1 sink pump with 30 inches of 1½-inch galvanized connecting pipe
- 4- or 5-inch vitrified sewer tile according to distance of tank from house

Labor—placing forms, laying brick, and concreting—70 hours.

4. **Type of Figure 5**

Bill of material from Kansas Engineering Experiment Station bulletin No. 5 for septic tank system for six persons:

Concrete
- 25 sacks cement
- 2 cubic yards sand
- 3 cubic yards gravel

Lumber for forms
- 200 feet B.M. 1-inch sheeting
- 45 feet B.M. 2x4

Steel—60 pounds reinforcing

Sewer pipe
- 150 ft. 5-inch vitrified clay
- 15 ft. 4-inch vitrified clay

Drain tile
- 350 ft. 4-inch

1 automatic sewer siphon

The excavation and labor items are not given by the Kansas bulletin but will probably run about as follows:

Excavation of pit—13 cubic yards.

Tile trench up to 4 feet deep—31 rods

Labor, placing forms and concreting—50 hours.

5. **Type of Figure 8a**

Excavation, figuring on 2 feet of earth over cover, 33 cubic yards

Concrete, 6½ cubic yards requiring

39 sacks cement

2-9/10 cubic yards sand

5-9/10 cubic yards gravel

Lumber for forms, risers, and covers

300 ft. B.M. 1-inch rough pine or fir

324 linear feet 2x4 rough pine or fir

130 linear feet ½x2 S-1-S pine or fir

135 linear feet 2x12 plank to cut in 5 ft. lengths

76 linear feet 1x6 S-4-S white pine or fir

32 linear feet 1x4 S-4-S white pine or fir

Total, 846 feet B.M.

Iron

12 pounds 3-inch wire nails

2 pounds 2-inch wire nails

3½ pounds ⅝-inch reinforcing iron (2 pieces 4 ft. long)

5 feet 2-inch gas pipe

2 nipples for 2-inch gas pipe, 3 inches long

4 2-inch elbows

4- or 5-inch vitrified sewer pipe, according to distance from building to tank and from tank to final outlet

Labor—placing forms and concreting—120 hours.

In all bills of material and labor it has been assumed that the soil in which the excavation is made will be firm enough to dig true to dimensions and so to serve for the outside forms. Where the excavation is in gravel, sand, or other loose material that will not stand straight or do for outside forms, the amount of form lumber will be somewhat more than double and the cubic yards of excavation will probably be from 3 to 7 or 8 times the amounts given.

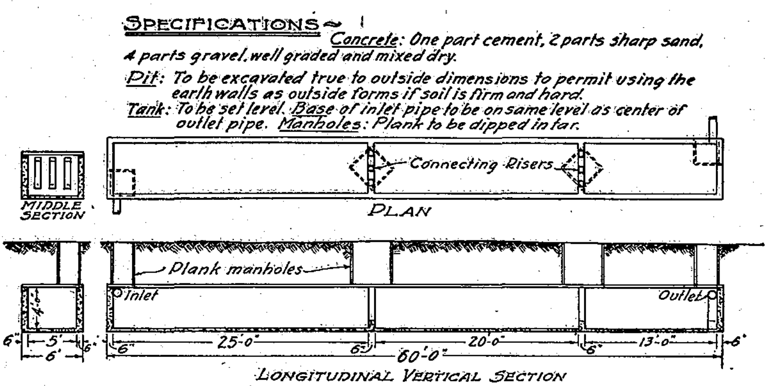


Fig. 8 Septic Tank Installed at Heron Lake Public School

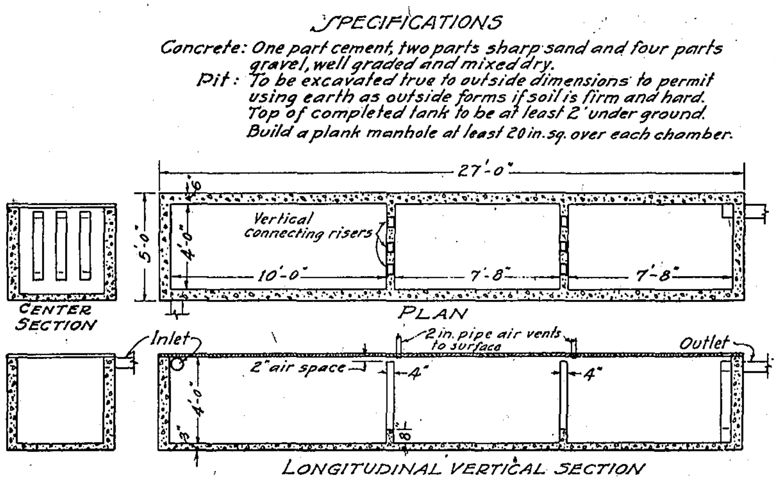


Fig. 8a Septic Tank for Small Coöperative Creameries

CONCLUSIONS

The best and simplest sewage disposal plant for the individual rural home at present is a two-chamber septic tank connected to a tile drain that has a good outlet or leading to an absorption bed if the tile drain is not available.

The general shape of the septic tank should be rectangular, the sludge chamber being about twice as long as it is wide, not more than 4 feet wide, with a fluid depth of about 30 inches and an air space above the scum of approximately one foot.

Light should be entirely excluded. There should be a slight circulation of air across the top of the fluid in the tank and either up through the house discharge and soil pipe or through a special vent provided near the tank on the house side. This circulation is required for best bacterial action and as an insurance against explosion of the tank from pent-up gases formed by the bacterial action. A small air vent should be provided as shown in Figure 1, into the tank itself from the outside.

The entrance and discharge of matter should be so controlled in the tank as to prevent disturbance of the bacterial scum which forms on the top of the liquid.

Acids and excess of greases should be excluded from the tank.

The sludge chamber should be of a size to accommodate house discharge up to 30 gallons per person during a 24-hour day.

The capacity of the tank should be figured from the intake level to the bottom, not from the top of the tank to the bottom.

The inlet and outlet of the sludge chamber in all tanks should be on the same level. The inlet and outlet of all tanks not equipped with automatic siphon discharge should be on the same level.

The bacteria that work in the sludge chamber are carried in the house sewage and action starts in from one to three weeks after use of the tank begins.

Septic tanks in continuous use as a rule work better than those used only intermittently.